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(54) [Title of the Invention] **Packaging Material for Enokitake Mushrooms, and Method of Production**

(57) [Abstract]

[Object] To provide a packaging material for Enokitake mushrooms, as well as its method of production, allowing the freshness of Enokitake mushrooms to be preserved better, with a more attractive packaging appearance.

[Structure] Material for packaging Enokitake mushrooms is in the form of a bag made from plastic film, or a lid and deep-drawn container. The plastic film of the bag, or either the lid or container in the case of a deep-drawn container, is or are irradiated with a pulse oscillation laser

to provide one or more micropores with a diameter of 100 ± 200 μm, so s to produce packaging for Enokitake mushrooms in which the oxygen permeability is 5,000 to 18,000 cc/m^2·24 hr·atm at 23°C.

[Claims]

[Claim 1] A packaging material for Enokitake mushrooms in the form of a bag comprising a thermally bonded plastic film with microporous sections, characterized in that the plastic film has an oxygen permeability of 5,000 to 18,000 cc/m^2·24 hr·atm at 23°C.

[Claim 2] A packaging material for Enokitake mushrooms comprising a flanged deep-drawn container and a lid of plastic film thermally bonded to the flanged portion of the container, characterized in that the lid and/or container comprise microporous sections, and the packaging material has an oxygen permeability of 5,000 to 18,000 cc/m^2·24 hr·atm at 23°C.

[Claim 3] A packaging material for Enokitake mushrooms according to Claim 1 or 2, characterized in that the microporous sections have micropores with a pore diameter of 100 ± 20 μm.

[Claim 4] A method for producing a packaging material in the form of a bag or a deep-drawn container provided with microporous sections to ensure an oxygen permeability of 5,000 to 18,000 cc/m^2·24 hr·atm at 23°C, characterized in that the container or the film forming the bag or container is irradiated with a pulse oscillation laser to provide microporous sections.

[Detailed Description of the Invention]

[0001]

[Technical Field to Which the Invention Belongs]

The present invention relates to a packaging material, and its method of production, for preserving the freshness of Enokitake mushrooms, and in particular relates to a freshness-preserving packaging material, and its method of production, for the distribution and sale of Enokitake mushrooms after they have been harvested and sorted into small individual packages.

[0002]

[Prior Art]

Shiitake mushrooms, Miitake mushrooms, Hiratake mushrooms, Tsukuritake mushrooms, Shirotamogitake (also known as Shimeji) mushrooms, and the like are, for the most part, shipped and sold in small individual portions in stretch-wrapped trays. The trays are made of soft polyvinyl chloride, drawn polystyrene, foamed polystyrene, polystyrene paper, or the like, and the stretch wrap film is soft polyvinyl chloride, polyethylene film, or the like. Enokitake

mushrooms, on the other hand, are vacuum packed in bags of undrawn polypropylene film and linear low density polyethylene (LLDPE) film.

[0003]

Mushrooms are generally characterized by high respiration and transpiration, and making it necessary to preserve their freshness when shipped and sold. For shipping and sales purposes, the forms of mushroom packaging described above do afford a certain degree of shape-retention and effects in preserving freshness such as 1) suitable MA (modified atmosphere) effects and 2) suitable effects in controlling transpiration.

[0004]

1) is a technique in which the gas permeability of the film and the respiration of the contents are exploited to preserve low oxygen and high carbon dioxide concentrations. MA is effective for mushrooms. The oxygen concentration in the container is reduced to ensure freshness by preventing the mushrooms from browning and by inhibiting aerial mycelia, for example. MA packaging is suitable for mushrooms because problems with low oxygen or high carbon dioxide are rarely encountered.

[0005]

2) is packaging intended to control deterioration caused by transpiration. Freshness is preserved very well when the container has suitable vapor permeability. When the vapor permeability is too high, the contents can dry out, resulting in a loss of commercial value, whereas when the vapor permeability is too low, the moisture inside the packaging can result in mold or spoilage, with a resulting loss of commercial value.

[0006]

[Problems Which the Invention Is Intended to Solve]

MA effects and suitable vapor permeability are thus essential in order to preserve the freshness of mushrooms. Vacuum packaging with polyethylene or polypropylene film, or the like, and shipping at low temperatures are effective for controlling shoot growth, opening, and browning after Enokitake mushrooms have been harvested and sorted into individual packaging.

[0007]

However, since Enokitake mushroom respiration is active at low temperatures as well, the odor of alcohol develops as a result of a lack of respiration under low oxygen conditions.

Although commercial value does not suffer in the initial stages of the development of the alcohol odor,.a continued lack of respiration will result in more potent alcohol odor or a disagreeable odor, which will affect commercial value. Because the packaging is hermetically sealed, the odor of alcohol or more disagreeable odor cannot be discerned, making it difficult to assess the commercial value of the Enokitake mushrooms. Furthermore, any relaxation of the vacuum in the vacuum packaging can cause the product to look unattractive or elicit concern over quality, discouraging potential consumer purchases. That is, problems in the vacuum packaging of Enokitake mushrooms are that the development of an alcohol odor before browning can cause a considerable loss of commercial value, while relaxation of the vacuum packaging caused by sealing defects or a lack of respiration can result in a less attractive appearance. Even when the vacuum remains intact, the deaeration can cause the surface to become irregular, resulting in indistinct print. An object of the present invention is thus to overcome such drawbacks by providing a packaging material for Enokitake mushrooms, as well as its method of production, to allow the freshness of Enokitake mushrooms to be preserved better, while simultaneously ensuring a more attractive packaging appearance.

[0008]

[Means for Solving the Abovementioned Problems]

As a result of extensive research undertaken to overcome the above drawbacks, the inventors perfected the present invention upon finding that a pulse oscillation laser could be used to open micropores in packaging materials, such as films used to hermetically seal Enokitake mushrooms, in order to adjust the oxygen permeability, so as to produce packaging for Enokitake mushrooms that more effectively preserved freshness, that was devoid of alcohol odor when opened, and that looked more attractive.

[0009]

That is, the invention in Claim 1 is a packaging material for Enokitake mushrooms in the form of a bag comprising a thermally bonded plastic film with microporous sections, wherein the micropores are adjusted to that the plastic film has an oxygen permeability of 5,000 to 18,000 cc/m^2·24 hr·atm at 23°C. The invention in Claim 2 is a packaging material for Enokitake mushrooms comprising a flanged deep-drawn container and a lid of plastic film thermally bonded to the flanged portion of the container, wherein the lid and/or container comprise

microporous sections, and the oxygen permeability of the packaging material is adjusted to between 5,000 and 18,000 cc/m^2·24 hr·atm at 23°C. The invention in Claim 3 is a packaging material for Enokitake mushrooms according to Claim 1 or 2, characterized in that the microporous sections have micropores with a pore diameter of 100 ± 20 μm. The invention in Claim 4 is a method for producing a packaging material in the form of a bag or a deep-drawn container provided with microporous sections to ensure an oxygen permeability of 5,000 to 18,000 cc/m^2·24 hr·atm at 23°C, characterized in that the container or the film forming the bag or container is irradiated with a pulse oscillation laser to provide microporous sections.

[0010]

[Embodiments of the Invention]

Embodiments and the like of the invention are described in detail below. In cases where the Enokitake mushroom packaging material of the invention is in the form of various types of thermally bonded bags, the plastic film that is used must be thermally bondable because it is heat sealed to form the bag and to seal the opening. It must also be able to absorb laser oscillation wavelengths, because micropores are formed by irradiation with a pulse oscillation laser. Any film having such properties can be used. Examples include heat sealable, drawn polypropylene film, undrawn polypropylene film, and polystyrene film, as well as laminated films comprising drawn polypropylene films which have been extrusion coated with a polyolefin resin such as polypropylene resin or low density polyethylene resin. Because polyethylene does not absorb laser oscillation wavelengths, it cannot be made porous in the form of a simple film, but when laminated as a sealant onto drawn polypropylene film as noted above, the drawn polypropylene film will be able to be heated and melted upon the absorption of the pulse oscillation laser, and the heat can thus be used to create pores in the polyethylene layer along with the drawn polypropylene film layer.

[0011]

When the packaging is in the form of a body-and-lid type of container comprising a flanged, deep-drawn container and a lid of a plastic film thermally bonded to the flanged portion of the container, the flanged portion of the deep-drawn container and the lid film are thermally bondable, and the deep-drawn container and/or lid film is or are provided with micropores by being irradiated with a pulse oscillation laser. As such, at least either the container or the lid must

be able to absorb laser oscillation wavelengths. In this regard, when a container formed of undrawn polypropylene sheets is used as the deep-drawn container, the lid can be made of a heat sealable, drawn polypropylene film or undrawn polypropylene film, or a laminated film comprising drawn polypropylene film extrusion coated with an easy-peeling resin or the like based on a polyolefin resin or a polypropylene resin. When the deep-drawn container is made of polyethylene, the lid film can be made of a laminated film of polypropylene and polyethylene, so that the lid can be provided with micropores.

[0012]

Bags formed by thermally bonding the above films or deep-drawn containers with lids made of such films are provided with the necessary number of pores having a diameter of 100 ± 20 μm by means of a pulsed oscillation laser, so as to adjust the oxygen permeability to between 5,000 and 18,000 cc/m^2·24 hr·atm at 23°C. The suitable oxygen permeability range for the individual packages is determined through experiment so that the aforementioned numerical value of the oxygen permeability will be obtained despite variable packaging dimensions. The value is given in terms of the oxygen permeability per square millimeter based on the surface area of the packaging.

[0013]

If the bag or deep-drawn container has an oxygen permeability less than 5,000 cc/m^2·24 hr·atm, it will not be possible to provide the bag or container with micropores, so that the interior of the packaging will result in low oxygen levels when Enokitake mushrooms are vacuum packaged as described above, with a greater likelihood of poor respiration causing disagreeable odors and a commensurate loss of commercial value. If, on the other hand, the oxygen permeability is greater than 18,000 cc/m^2·24 hr·atm, it will not be possible to reduce the oxygen concentration in the packaging, and the resulting respiration and transpiration can result in a loss of freshness such as spoilage or softening due to condensation.

[0014]

The micropores that are provided in order to adjust the oxygen permeability of the Enokitake mushroom packaging material in the invention should be about 100 ± 20 um in diameter. One or two micropores with a diameter of 100 μm will usually allow the oxygen permeability of the small individual packaging units of the Enokitake mushrooms to be adjusted

to within the aforementioned range. A pore diameter of a constant size below 100 μm, such as about 50 μm, will permit finer adjustment, but a diameter of 100 ± 20 μm is more practical in terms of dimensional stability and ease of production.

[0015]

Although methods involving the use of heated needles have been used to provide fine pores, they suffer from poor dimensional stability when it comes to pores of such a small size. In this respect, pulse oscillation type lasers are capable of efficiently producing pores having a diameter of 100 μm or less with good dimensional stability. Any type of laser can be used, such as carbon dioxide gas lasers, YAG lasers, semiconductor lasers, and argon ion lasers. The packaging material must be capable of absorbing laser oscillation wavelengths in order to form micropores. In this regard, carbon dioxide gas lasers are particularly suitable for use.

[0016]

When the packaging material used to wrap the above individual small packages is, for example, a 17 cm × 10 cm bag with one micropore 100 μm in diameter, the oxygen permeability will increase about 200 cc/bag·24 hr·atm. Because the oxygen permeability will increase proportionally to the total surface area of the porous section, the number of micropores that are provided can be adjusted to obtain a packaging material with an oxygen permeability in the general desired range.

[0017]

Packaging produced using the above material may be in the form of any kind of bag, such as pillow types, three-sided seal types, four-sided seal types, standing pouches, and gusset types, as well as any kind of deep-drawn containers.

[0018]

[Examples]

The invention is illustrated in greater detail in the following examples and comparative examples.

Example 1

In this example, the packaging was in the form of a deep-drawn container. The lid was made of a 40 μm thick cast polypropylene film (CPP film). One micropore with a diameter of 100 μm was provided per packaging unit using a pulse oscillation laser. The lid dimensions were

17 cm × 10 cm. An 80 μm thick CPP film was used for the deep-drawn container. The container was produced by vacuum compression molding the material in a mold outer into a flanged rectangular tray 30 mm deep measuring 17 cm × 10 cm, with an 8 mm wide flanged portion.

[0019]   Example 2

In this example, the packaging was in the form of a four-sided seal type of bag. A 30 μm thick CPP film was used. Two micropores with a diameter of 100 μm were provided per bag using a pulse oscillation laser. The bag was 17 cm × 10 cm, sealed on three sides, with a seal width of 5 mm.

[0020]   Comparative Example 1

A container was produced in the same manner as in Example 1, with without providing any micropores in the lid, resulting in a nonporous deep-drawn container designated the container of Comparative Example 1.

[0021]   Comparative Example 2

A deep-drawn container with the same structure as in Example 1 was produced except that the lid was provided with four micropores having a diameter of 100 μm per packaging unit. This was designated the container of Comparative Example 2.

[0022]   Measurement of Oxygen Permeability

The oxygen permeability of the containers and bag of Examples 1 and 2 and Comparative Examples 1 and 2 was determined in accordance with JIS K7126 (A). The values in Table 1 are expressed in terms of m^2 units based on the calculated surface area.

[0023]

[Table 1]

	Oxygen permeability (23°C) ($cc/m^2 \cdot 24\ hr \cdot atm$)
Example 1	7,200
Example 2	16,900
Comparative Example 1	2,000
Comparative Example 2	23,000

[0024]   Enokitake mushroom packing and preservation test and results

Twenty containers and bags of Examples 1 and 2 and Comparative Examples 1 and 2 were each filled with 100 g Enokitake mushrooms and sealed, resulting in Enokitake mushroom packaging samples of Examples 1 and 2 and Comparative Examples 1 and 2. Only Comparative

Example 1 was vacuum packaged. The packaging samples were stored for 2 days at 5°C and then for another four days at 15°C. The changes in the gas composition (O_2, CO_2) in the packages and the changes in the quality of the Enokitake mushrooms were studied during the storage at 15°C. The results are given in Tables 2 and 3.

[0025]

[Table 2] Oxygen and Carbon Dioxide Gas Concentration (%) in the Packages

		Gas concentration in packages (%)			
		Day 1	Day 2	Day 3	Day 4
Example 1	oxygen carbon dioxide	1.9 14.7	1.4 14.5	2.9 13.5	0.9 13.7
Example 2	oxygen carbon dioxide	2.8 14.7	1.9 14.8	3.1 15.1	1.3 14.2
Comp. Ex. 1	oxygen carbon dioxide	ND 22.2	0.06 15.3	2.2 11.8	1.6 11.4
Comp. Ex. 2	oxygen carbon dioxide	4.6 14.8	2.5 15.0	3.4 16.2	1.8 15.8

(Note) ND in the table means "not determined."

[0026]

[Table 3] Changes in quality of Enokitake mushrooms (odor, appearance)

		Quality			
		Day 1	Day 2	Day 3	Day 4
Example 1	Odor	good	slight alcohol odor	slight alcohol odor	some alcohol odor
	Appearance	good, some condensation	good, some condensation	good, a little sticky	good, a little sticky
Example 2	Odor	good	slight alcohol odor	slight alcohol odor	slight alcohol odor
	Appearance	good, some condensation	good, some condensation	good, a little sticky	good, a little sticky
Comp. Ex. 1	Odor	slight alcohol odor	alcohol odor	strong alcohol odor	strong alcohol odor
	Appearance	good	good, some condensation	good, some condensation	good, a little sticky
Comp. Ex. 2	Odor	good	slight alcohol odor	slight alcohol odor	some alcohol odor
	Appearance	good, some condensation	condensation throughout, very musty	increased condensation, softening of mushrooms	about 50% loss of commercial value

[0027]

The results in Table 3 show that the packaging for Enokitake mushrooms in Examples 1 and 2, in which micropores had been provided to allow the oxygen permeability to be suitably adjusted, suffered no unpleasant odors, even after 4 days at 15°C (total of 6 days), and had good

results, with little stickiness. In addition, the lack of vacuum packaging resulted in an attractive appearance, without any surface wrinkling or unevenness. By contrast, the packaging in Comparative Example 1 resulted in an alcohol odor on Day 1 at 15°C, which became quite strong by Day 4. Although the unpleasant alcohol odor was not as pronounced in Comparative Example 2, considerable condensation resulted in side the packaging, causing the mushrooms to soften by Day 3 at 15°C, with about a 50% loss of commercial value by Day 4.

[0028]

[Merits of the Invention]

As noted in detail above, the packaging for Enokitake mushrooms in the present invention is provided with micropores, allowing the oxygen permeability to be adjusted to between 5,000 and 18,000 $cc/m^2 \cdot 24\ hr \cdot atm$ at 23°C. There is thus no need for vacuum packaging. The oxygen concentration in the packaging can be kept at appropriate levels, even though the mushrooms are packaged in the presence of air, allowing alcohol odor and disagreeable odors to be controlled. Because odor can be expelled through the micropores, it is possible to avoid discomfort caused by disagreeable odors during sealing (such as alcohol odor) which have been a problem in the past, while also ensuring that freshness can be preserved longer. Because there is no need for conventional vacuum packaging, can be packaged more rapidly, and products will look more attract because none of the surface unevenness caused by the vacuum will occur and print will be more distinct. In the method for producing packaging for Enokitake mushrooms in the invention, a pulse oscillation type of laser is used to form micropores in order to adjust the oxygen permeability of the bag or deep-drawn container to within a suitable range. In this method, the necessary number of micropores with a diameter of 100 μ or less can be provided continuously with good accuracy at the desired pitch, allowing Enokitake mushroom packaging with suitable oxygen permeability to be efficiently produced.